DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
Submission of Proposals

DARPA=s charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the DARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military and dual-use applicability as the budget and other factors will allow.

DARPA has identified 24 technical topics, numbered DARPA SB982-007 through DARPA SB982-030, to which small businesses may respond in the second fiscal year (FY) 98 solicitation (98.2). Please note that these topics are UNCLASSIFIED and only UNCLASSIFIED proposals will be entertained. These are the only topics for which proposals will be accepted at this time. A list of the topics currently eligible for proposal submission is included, followed by full topic descriptions. The topics originated from DARPA technical offices.

Please note that **5 copies** of each proposal must be mailed or hand-carried; DARPA will **not** accept proposal submissions by electronic facsimile (fax). A checklist has been prepared to assist small business activities in responding to DARPA topics. Please use this checklist prior to mailing or hand-carrying your proposal(s) to DARPA. Do not include the checklist with your proposal.

It is expected that the majority of DARPA Phase I awards will be Firm Fixed Price contracts. Phase I proposals **shall not exceed $99,000**. DARPA Phase II proposals must be invited by the respective Phase I technical monitor (with the exception of projects that qualify for the Fast Track – see Section 4.5). DARPA Phase II proposals must be structured as follows: the first 10-12 months (base effort) should be approximately $375,000; the second 10-12 months of incremental funding should also be approximately $375,000. The entire Phase II effort should not exceed $750,000. It is expected that a majority of the Phase II contracts will be Firm Fixed Price-Level of Effort or Cost Plus Fixed Fee.

The responsibility for implementing DARPA=s SBIR Program rests with the Administration and Small Business Directorate (ASBD). The DARPA SBIR Program Manager is Ms. Connie Jacobs. DARPA invites the small business community to send proposals directly to DARPA at the following address:

DARPA/ASBD/SBIR
Attention: Ms. Connie Jacobs
3701 North Fairfax Drive
Arlington, VA 22203-1714
(703) 526-4170
Home Page http://www.darpa.mil

SBIR proposals will be processed by DARPA ASBD and distributed to the appropriate technical office for evaluation and action.

DARPA selects proposals for funding based on technical merit and the evaluation criteria contained in this solicitation document. DARPA gives evaluation criterion a., **?**The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution@ (refer to section 4.2 Evaluation Criteria - Phase I - page 7), twice the weight of the other two evaluation criteria. As funding is limited, DARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and highly relevant to the DARPA mission. As a result, DARPA may fund more than one proposal in a specific topic area if the technical quality of the proposal(s) is deemed superior, or it may fund no proposals in a topic area. Each proposal submitted to DARPA must have a topic number and must be responsive to only one topic.

In order to ensure an expeditious award, cost proposals will be considered to be binding for a period of 180 days from the closing date of this solicitation for Phase Is, and for 180 days from proposal receipt for Phase IIs. For contractual purposes, proposals submitted to DARPA should include a statement of work which does not contain proprietary information. Successful offerors will be expected to begin work no later than 30 days after contract award. For planning purposes, the contract award process is normally completed within 30 to 60 days from issuance of the selection notification letter to Phase I offerors.

On a pilot basis, the DoD SBIR Program has implemented a streamlined Fast Track process for SBIR projects that attract matching cash from an outside investor for the Phase II SBIR effort, as well as for the interim effort between Phases I and II. Refer to Section 4.5 for Fast Track instructions. DARPA encourages Fast Track Applications between the 5th and 6th month of the Phase I effort. Technical dialogue with DARPA Program Managers is encouraged to ensure research continuity during the interim period and Phase II. If a Phase II contract is awarded under the Fast Track program, the amount of the interim funding will be deducted from the Phase II award amount. It is expected that interim funding will not exceed $40,000.

DARPA 1998 Phase I SBIR
Checklist

1) Proposal Format

   a. Cover Sheet - Appendix A (identify topic number) ______

   b. Project Summary - Appendix B ______

   c. Identification and Significance of Problem or Opportunity ______

   d. Phase I Technical Objectives ______

   e. Phase I Work Plan ______

   f. Related Work ______

   g. Relationship with Future Research and/or Development ______

   h. Commercialization Strategy ______

   i. Key Personnel, Resumes ______

   j. Facilities/Equipment ______

   k. Consultants ______

   l. Prior, Current, or Pending Support ______

   m. Cost Proposal (see Appendix C of this Solicitation) ______

   n. Company Commercialization Report - Appendix E ______

2) Bindings

   a. Staple proposals in upper left-hand corner. ______

   b. **<u>Do not</u>** use a cover. ______

   c. **<u>Do not</u>** use special bindings. ______

3) Page Limitation

   a. Total for each proposal is 25 pages inclusive of cost proposal and resumes. ______

   b. Beyond the 25 page limit do not send appendices, attachments and/or additional references. ______

   c. Company Commercialization Report (Appendix E) is not included in the page count. ______

4) Submission Requirement for Each Proposal

   a. Original proposal, including signed Appendices A and B. ______

   b. Four photocopies of original proposal, including signed Appendices A ,B and E. ______

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DARPA SB982-008	Grafting of Thin Films and Microstructures for Microencapsulation and Polylithic Integration
DARPA SB982-009	Novel Applications for Inorganic High Surface Area Materials
DARPA SB982-010	Data Driven Rapid Prototyping and Fabrication of Electronic Components
DARPA SB982-011	Combinatorial Synthesis of New Materials
DARPA SB982-012	Composite Materials for High Performance Stages in Lithography Tools
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DARPA FY98.2 TOPICS DESCRIPTIONS

DARPA SB982-007 TITLE: Low Power Micro-Sensor Suites for Environmental Conditions Monitoring

CRITICAL TECHNOLOGY AREA: Environmental Quality

OBJECTIVE: Develop a modular suite of micro-sensors for health monitoring of missiles/weapon systems; emphasizing small size, low power consumption, and low-cost for environmental conditions sensing. The Microelectromechanical Systems (MEMS) devices shall be capable of detecting and/or measuring real-time extremes in temperature, humidity, shock, strain, and adverse chemical presence for the early warning health monitoring of missiles in their storage containers. To develop sensors that can resolve vibrations in dynamic environments; such as in helicopter and aircraft missile pods while in-flight, and in buildings and lifeline facilities (e.g. bridges, gas lines, sewer lines) in the presence of passing seismic waves.

DESCRIPTION: A unique application of MEMS involves monitoring the health of missile/weapon systems during shipping, in storage, under pre-launch conditions, and possibly during post launch scenarios. Tremendous logistics cost savings can be realized through the use of condition- based maintenance. A suite of miniature sensors is required to continually monitor missile/weapon systems and various field equipment. Although not limited to any particular sensor technology, MEMS and/or optical fiber sensor technologies are the logical candidates for fulfilling low power, small size, low-cost objectives. The micro-sensor devices should be applicable to structural health monitoring and must operate beyond military specifications. The sensors must respond to low and high alarm modes and mechanical failure mechanisms, and provide warning to allow for the proactive maintenance of equipment. Low power and small size are crucial to remote sensing. The suite of sensors should be modular in that each weapon system requires a different 'set' of sensors. The outcome of this project should provide a low-cost, early warning health monitoring system that continuously monitors environmental conditions (See Attachment 1) and potential mechanical failure mechanisms, and responds to low and high alarms outside the environmental specifications.

PHASE I: The Phase I effort shall investigate various microelectromechanical sensors and sensing techniques for detecting/measuring environmental conditions such as temperature, humidity, shock, strain, and adverse chemicals. Conduct a review of the progress of MEMS against the requirements for the health monitoring of at least three (3) different missile systems. Provide detailed analysis of all feasible solutions and limitations available using existing sensors. Recommend a low-cost approach that will meet the criteria described in this topic.

PHASE II: The Phase II effort shall develop and demonstrate a prototype modular sensor suite for early warning health monitoring of missile/weapon systems. Test the sensors in a laboratory environment to verify performance. Provide detailed description of the suite of sensors. Provide test data.

PHASE III DUAL USE APPLICATIONS: The suite of micro-sensors will provide warranty claims avoidance for many high-dollar systems (high-tech equipment, automobiles, etc.), as well as weapon systems. The suite of micro-sensors developed under this SBIR project also has direct application to earthquake damage assessment, structural degradation/health monitoring, home health monitoring, and medical/cleanroom facilities monitoring.

ATTACHMENT 1: MISSILE HEALTH SENSOR SUITE SPECIFICATIONS

Temperature: Provide "alert trigger" for out-of-spec conditions as follows:
Temperature falls below -57°C
Temperature exceeds +95°C
Temperature Rate-of-Change exceeds 1.7°C/second

Shock: Provide "wake-up" sensor for shocks of 30 g's.
Provide "alert trigger" for a single shock of 86 g's.

Vibration: Trigger alert for sustained random vibrations of 8.9 g's RMS after 30 seconds.

Humidity: Trigger alert for humidity levels exceeding 95% over the full temperature range specification.

Chemical: Trigger for atmospheric salt levels greater than 5% salt.
Trigger for out-gassing of TBD chemicals at levels exceeding TBD%.

Acoustic: Trigger alert for acoustic noise levels greater than 180 dB.
Strain: Trigger alert for missile skin strains exceeding 10-2 over the temperature range.
Trigger wake-up for sustained strains exceeding 10-4 after 1 hour.

REFERENCES:

1. Mehregany, Mehran, et al., "Introduction to Microelectromechanical Systems and the Multiuser MEMS Processes," Case Western Reserve University Short Course Handbook, Department of Electrical Engineering and Applied Physics, August, 1993.
This handbook may be obtained from:

Case Western Reserve University
Electronics Design Center
Department of Electrical Engineering and Applied Physics
ATTN: Dr. Mehran Mehregany
Cleveland, OH 44106-7200
mehran@mems5.cwru.edu
(216) 368-6435

2. Proceedings of the Tenth Annual International Workshop on Micro Electro Mechanical Systems, IEEE Catalog Number 97CH36021, Nagoya, Japan, 26-30 January 1997. The proceedings may be obtained from:

IEEE Copyrights Manager	IEEE Catalog Number 97CH36021
IEEE Service Center	ISBN 0-7803-3744-1 (softbound)
445 Hoes Lane	ISBN 0-7803-3745-X (casebound)
P. O. Box 1331	ISBN 0-7803-3746-8 (microfiche)
Piscataway, NJ 08855-1331	ISBN 1084-6999

DARPA SB982-008 TITLE: Grafting of Thin Films and Microstructures for Microencapsulation and Polylithic Integration

CRITICAL TECHNOLOGY AREA: Electronics

OBJECTIVE: Develop processes and equipment that allow straightforward, high-speed, automated grafting of mechanical and electronic microstructures for highly integrated microsystems.

DESCRIPTION: Evolving Microelectromechanical Systems (MEMS) technologies have the potential to greatly shrink microsystem volume while increasing sensing and processing capabilities. Using fabrication techniques similar to those in the microelectronics industry, MEMS fabrication processes can create mechanical, optical, or electrical functions on a substrate in large quantities, promising high performance at low cost. However, combinations of these functions are difficult to achieve on a single substrate due to material and processing incompatibilities. Also, many of these devices, such as inertial sensors and resonators, must be sealed in a vacuum, and/or mechanically protected from the environment. A straightforward, mechanically-based method is needed to graft sensors and micro-packages fabricated separately to a single Complementary Metal Oxide Silicon (CMOS) processor substrate to allow multi-function subsystems. This effort will require the development of techniques, processes, materials and equipment to allow wafer-scale bonding of MEMS devices and micro-packages to a host substrate.

PHASE I: Develop/enhance generic processes for mechanically grafting MEMS devices onto a substrate. Characterize robustness and placement accuracy of devices, micro-packages, and bonds after grafting and post processing. Simplify processes to reduce cost and aid in later automation. Investigate multiple grafting of different devices on the same substrate and grafting on a wafer scale. Investigate mechanical grafting of electronic devices in Si and III-V material systems. Investigate micro-sealing techniques for standard plastic encapsulated circuits. Fabricate and functionally test demonstration devices with a transferred micro-package and one or more MEMS devices onto a functional CMOS substrate.

PHASE II: Develop automated or semi-automated processes using the techniques from Phase I. Demonstrate the improved processes for one or more microsystem designs. Environmentally test fabricated devices for robustness. Develop design for manufacturing software to aid in commercial microsystem design using developed processing techniques. Determine range of potential applications and high payoff areas. Enhance and harden processes to increase reliability, repeatability, yields, and lower cost. Develop a productization plan for commercializing the developed processes/equipment.

PHASE III DUAL USE APPLICATIONS: Forecasts for MEMS products show a $12-$14 billion market by the year 2000. Much of this market will be as sub-components for commercial products such as automobiles, printers, mass data storage, and telecommunications. The commercial market will drive the availability and cost of MEMS-based microsystems. Any improvements in performance, functionality, and cost brought about by skillfully combining various MEMS devices, Very Large Scale Integration (VLSI) CMOS, and micro-packaging can only increase market projections and lead to affordable off-the-shelf technology for military use. In addition, this technique may allow low-cost hermetic packaging of microcircuits for medical, industrial, and military high reliability requirements.

REFERENCES:
1. Cohn, M.B., et al, AWafer-to-Wafer Transfer of Microstructures for Vacuum Packaging,@ 1996 Solid State Sensor and Actuator Workshop, Hilton Head Island, SC, USA, June 2-6, 1996. Transcripts of this reference can be ordered from:

Transducer Research Foundation, Inc.
1356 Forest Hills Blvd.

Cleveland, OH 44118
Charge is $6.00 per copy. Make checks out to ?TRF@
TRF web page is ?http://www-bsac.eecs.berkeley.edu/trf/@
2. Cohn, M.B., ?Assembly Techniques for Microelectromechanical Systems,@ Doctor of Philosophy Thesis Paper, Fall 1997. The paper can be found at ?http://robopc.eecs.berkeley.edu/bsac/thesis@
3. AMicroelectromechanical Systems@, a Dept. of Defense Dual-Use Technology Industrial Assessment Final Report, December 1995. The Final Report may be obtained by calling the SBIR Office at (703) 526-4170.
4. DARPA internet site with MEMS information: http://www.darpa.mil/ETO/MEMS/index.html

DARPA SB982-009 TITLE: Novel Applications for Inorganic High Surface Area Materials

CRITICAL TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Demonstrate and incorporate in novel prototype product demonstrations of interest to the Department of Defense (DoD), the fabrication of manufacturable inorganic high surface area materials that are thermally, chemically, and mechanically stable for technology areas such as gas separation, catalysis, sensors, superinsulators, ultrasonic devices, or sound insulation, etc.

DESCRIPTION: The engineering of high surface area materials is emerging as a new area of great technological interest; however, beyond improving the synthesis and processing of these materials, future directions in this field are envisioned to be driven by applications [1-3]. A few specific application areas for high surface area materials of interest to the DoD and commercial industries include, but are not limited to, in situ separation of hydrogen as it generated in permselective membranes to create ultra-pure hydrogen gas for fuel cells, high-surface area membranes that allow the permeation of oxygen, but not water, for underwater (artificial gills) applications, chemical and biological sensing and/or neutralization devices, encapsulant applications requiring thermal isolation and/or insulation, as well as applications that require the ability to hide the acoustic signature of structures. Some of the aforementioned applications (e.g., gas separation) may require the development of manufacturable high surface area materials with controlled and tailored porosity. The proposals must clearly state how the proposed technology advances the state-of-the-art of high surface area materials and have a clearly defined prototype product demonstration of particular interest to the DoD.

PHASE I: Demonstrate the feasibility and pilot-scale manufacturability of high surface area materials to enable the proposed application.

PHASE II: Demonstrate that the proposed application areas are truly enabled or significantly improved through the integration of inorganic high surface area materials using real prototype demonstration vehicles. The device demonstration vehicles and the testing results must be delivered.

PHASE III DUAL USE APPLICATIONS: The unique properties of manufacturable, high surface area inorganic materials will be exploited in various applications such as catalysis, gas separation for fuel cell applications, molecular sieving, thermal insulation which can be exploited in uses such as improved refrigeration efficiency, hiding infra-red signatures of vehicles, etc., acoustic insulation, and chemical sensing for monitoring chemical plants, thus expanding their commercial use and awareness. The proposed application areas for the high surface area materials will facilitate a market pull for the technology instead of the classic technology push.

REFERENCES:
1. A. Sayari, ?Periodic Mesoporous Materials: Synthesis, Characterization and Potential Applications,@ H. Chon, S. I. Woo, and S. E. Park, editors, *Recent Advances and New Horizons in Zeolite Science and Technology,* Studies in Surface Science and Catalysis, Vol. 102, (Elsevier Science B.V., 1996). pg.1.
2. C. J. Brinker, ?Porous Inorganic Materials,@ *Current Opinion in Solid State and Materials Science*, pg. 798 (1996).
3. V. Wittwer, ?Development of Aerogel Windows,@ *J. Non-Crystalline Solids*, Vol. 145, 233 (1992).

DARPA SB982-010 TITLE: Data Driven Rapid Prototyping and Fabrication of Electronic Components

CRITICAL TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Establish a microfabrication capability which entails maskless computer driven machine tools such as inkjets, micro-pens, laser direct write technologies, laser chemical vapor deposition (LCVD), etc., to enable the rapid fabrication of light-weight, three-dimensional electronic devices (resistors, capacitors, inductors, interconnects, batteries, and antennae) and components on planar and non-planar substrates.

DESCRIPTION: Research and development of computer aided design/computer aided machine (CAD/CAM) tools to enable the rapid prototyping, miniaturization, and three-dimensional fabrication of customized simple electronic components (resistors, conductors, inductors, capacitors, batteries, and antennae) on both planar and non-planar substrates are being developed under DARPA=s Mesoscopic Integrated Conformal Electronics (MICE) Program. Efforts of interest include the development of CAD/CAM tools necessary to directly deposit a variety of functional materials (metals, metal oxides, dielectrics, ferrites, polymers, etc.) with 10 micron-sized features in a multi-layer fashion; tools that enable or accelerate the prototyping of new processes, devices, modules, or electronic sub-systems; the development of functional materials that can be deposited at low-temperatures utilizing the aforementioned CAD/CAM tools; and computer simulations of electro-magnetic interactions of passive components (resistors, capacitors and inductors) deposited in a multi-layer fashion. The proposals must clearly state how the proposed technology advances the state-of-the-art for the rapid prototyping of electronic components and have a clearly defined prototype device demonstration.

PHASE I: Demonstrate the feasibility of using the proposed smart manufacturing machine, functional materials, or computer simulation to fabricate simple electronic components.

PHASE II: Manufacture a computer-driven, maskless microfabrication tool that enables the deposition of a variety of functional materials using a multi-layered architecture design that is substrate invariant (planar and non-planar substrates, smooth and rough surfaces). Simple electronic test coupon devices and the testing results must be delivered.

PHASE III DUAL USE APPLICATIONS: The development of data driven materials deposition tools will expand commercial markets such as the wireless communications market (cellular phones, pagers, Global Positioning System units, radio-frequency identification tags for property tracking, etc.), as well as applications that use smart-cards through the ability to fabricate highly compact, ultra-lightweight electronic assemblies in a multi-layer fashion at low-substrate temperatures without the need for a printed wiring board. The rapid prototype fabrication time will markedly shorten the product design cycle for dual-use systems and provide significant advantages to system developers when testing new ideas, concepts, or materials.

DARPA SB982-011 TITLE: Combinatorial Synthesis of New Materials

CRITICAL TECHNOLOGY AREA: Materials, Processes and Structures

OBJECTIVE: Use of combinatorial synthesis to discover new, significantly improved materials with interesting properties relevant to DoD.

DESCRIPTION: Combinatorial synthesis is a powerful technique for searching for new materials with unique properties. This technique is described in several recent articles that highlight the significant potential of this technique for materials discovery (see References 1-5). DARPA is seeking innovative proposals to use this technique to search for and optimize new materials that include, but are not limited to, high-temperature, high mechanical strength, high energy product permanent magnets; very low loss electrically or magnetically tunable ferroelectrics or ferrites; extremely high or low permitivity materials; and high figure of merit thermoelectrics.

This solicitation is seeking to develop significantly improved materials, not just incremental improvements on existing materials systems. The proposer should identify the candidate materials system(s) to be screened, what improved properties will be sought, and the significance to both DoD and commercial industry.

PHASE I: Develop experimentation plan and property testing methods. Begin experiments to look for new materials of interest to DoD. Establish approximate stoichiometry and structure.

PHASE II: Complete experiments to identify new materials. Perform optimization searches around most interesting candidate materials. Fully characterize best new materials and transition to component device manufacturers.

PHASE III DUAL USE APPLICATIONS: The proposer should choose to explore materials systems and properties that are relevant to both DoD and civilian applications. High temperature, high energy product magnets are important in both military and civilian power and propulsion systems. High dielectric and low dielectric materials have many applications to electronics, particularly those associated with communications and remote sensing. Extremely high dielectric constant materials are useful in energy storage devices for civilian portable electronics and military unattended ground sensors. Thermoelectric materials are very important for the thermal management of sensors and electronics, cooling of hybrid vehicles, and waste heat recovery for enhanced efficiency.

REFERENCES:

1. A Combinatorial Approach to Materials Discovery, X, -D Xiang et al, Science, 268, 1788 (1995) plus cover.
2. A Class of Cobalt Oxide Magnetoresistive Materials Discovered with Combinatorial Synthesis, Gabriel Briceno et al. Science, 270, 273 (1995).
3. High Speed Materials Design, Robert F. Service, Science, 277, 474, (1997).
4. A Combinatorial Approach to the Discovery and Optimization of Luminescent Materials, Earl Danielson et al., Letters to Nature, 389, 944 (1997).
5. Orquest and Symyz: 2 Hot Venture Capital Investments, San Francisco Chronicle, November 7th, 1997.

DARPA SB982-012 TITLE: Composite Materials for High Performance Stages in Lithography Tools

CRITICAL TECHNOLOGY AREA: Electronics; Manufacturing Science and Technology (MS&T); Materials, Processes, and Structures

OBJECTIVE: Develop structures of composite materials for high performance stages for lithography tools.

DESCRIPTION: The continuing advancement of cost-performance benefits in microelectronics places increased demands upon the lithography tools. Composite materials offer a variety of potential advantages over the stage materials currently in use. The wafer and mask stages in these lithography tools must meet exacting requirements in both position control and stage motion. Just as the feature sizes of transistors decrease by 30% with each generation of microelectronics, so must the tolerance in alignment between the many levels which define the transistors and interconnect. For the 0.1 micron design rules, the nominal alignment tolerance must approach 25 nm. Cost-effective manufacturing of the future will require larger wafers (300 mm diam.) and the larger chips will require larger masks (225 mm). Higher stage speeds and faster changes of direction are required to minimize overhead. Composite materials offer gains in areas such as weight, vibrational stability, and thermal expansion. Improved stage performance is required for a variety of tools including scanners, mask writers, inspection, and mask repair.

PHASE I: Explore the exacting requirements of high performance stages, evaluate the parameters of composite materials against these requirements, and prepare a design for one or more applications listed above.

PHASE II: Fabricate a prototype stage, integrate into a test configuration, and characterize the subsystem performance against the design criteria.

PHASE III DUAL USE APPLICATIONS: The developments will provide potential solutions in the key areas of microelectronics and micromechanical structures. The improved stages will accelerate the fabrication of semiconductor devices with increased switching speeds at lower power and with increased functional complexity. The military gains include the higher performance microelectronics for signal processing applications in areas such as command and control, communications, surveillance, electronic warfare, and target recognition. Commercial markets will gain from the increased memory densities and faster microprocessor clocking for computer applications affecting all sectors of society.

DARPA SB982-013 TITLE: Miniature,Low-Cost Near-InfraredChemometric Spectrometer

CRITICAL TECHNOLOGY AREA: Sensors; Chemical and Biological Defense

OBJECTIVE: Design and engineering of a chemometric spectrometer for the analysis and detection of certain chemical species in fluids and solids.

DESCRIPTION: Many analytic applications require the chemometric analysis of near-infrared reflection, absorption, or transmission spectra of fluids or solids. Examples from the military arena include analysis of air samples for toxic chemical traces, analysis of water samples for hazardous contaminants, or the spectroscopic analysis of smoke for certain chemicals. From the commercial sector, some common examples include the determination of the octane number of blended gasoline, the glucose concentration in blood, the sugar content of agricultural products, or the moisture content of pulp and paper. Current spectroscopic technologies such as rotating grating, far-infrared Fourier transform spectroscopy, and diode array spectrometers all suffer from some combination of instability from moving parts, slow data acquisition, large size, and high cost. Since most applications only require the measurement of a limited range of wavelengths, application-specific spectrometers sensitive only in this limited range of wavelengths can be constructed. Arrays of these narrow band spectrometers can then be arranged to extend the spectrum whenever the need arises. This solicitation calls for the development of an ultra-small and compact [contained in an Integrated Circuit (IC) package, such as a Multi-Chip Module (MCM)], low-cost, application-specific spectrometer. The basic concept of the device should be extendable to cover a wide range of wavelengths in an array configuration.

PHASE I: Conduct a detailed study, including identification of the target application(s), and a detailed design that may conclude with a limited conceptual demonstration.

PHASE II: Implement the design and the conceptual demonstration of Phase I into a complete working system capable of analyzing and detecting certain chemical species and/or their concentrations in a fluid or solid. A prototype system, with all relevant documentation and software (if applicable) must be delivered.

PHASE III DUAL USE APPLICATIONS: The development of chemometric spectrometers that are small, compact, low-cost and easy to use will find a wide range of applications in both the commercial and military sectors. The food and drug industry would use these spectrometers in the rapid and low-cost analysis of food or drug substances for concentrations of certain chemical species in the products. When appropriately tailored, these spectrometers would also be useful in the detection of harmful chemicals in the battlefield. Most common industrial chemicals are extremely hazardous when released in sufficiently high concentrations (examples include hydrogen fluoride vapor, carbon dioxide or monoxide gas, nitrous oxide gas, and fumes from burning crude oil mixed with chemicals). Thechemometric spectrometer would be a useful analysis tool for chemicals of this kind.

DARPA SB982-014 TITLE: Advanced Information Filtering/Retrieval Techniques

CRITICAL TECHNOLOGY AREA: Human Systems Interface

OBJECTIVE: Develop techniques and algorithms that allow for complex searches and retrieval from large, distributed databases that are poorly organized. Algorithms and techniques developed must support scalability, portability, flexibility and theoretically sound realizations. Optimization models must be developed. The techniques developed should support very complex queries by inexperienced users and take into account, in part by interaction with the user, such issues as refinement via inspection of acceptable/non-acceptable returns, cultural bias, etc. Sustained, acceptable system performance is paramount.

DESCRIPTION: The primary thrust behind the desired architectural information infrastructure research is that we are now in serious data overload - humans can not catalog all the information that is being produced. Areas of user interest are fluid and change quickly over short time intervals. Information Systems today are special purpose in nature and are focused on user request processing - that is, go find something about this subject right now. The query is dynamic and the search domain is static. This technique is fine assuming users are able to take the time to work with the system and get the data they need. Solutions that rely on diverse applications can enhance user requests without requiring significant software development. Performance optimization is critical to support large volume data applications.

PHASE I: Identify advanced concepts/algorithms which will offer potential improvement in the ability of inexperienced users to search a large, disorganized data base and be able to rapidly retrieve desired information. Identify several prime candidates for development in a Phase II program. Low to medium technical risk and high potential for successful development will be included in the ?technical merit@ selection criteria. Identify experimentation techniques and metrics that would be used in a PHASE II effort to validate.

PHASE II: Develop and test one or more techniques/algorithms selected in Phase I by integration within an existing data base structure as proposed in PHASE I. Execute experiments to validate the concepts/algorithms developed against the metrics identified in PHASE I. As a minimum, one configuration should be a Joint level military command and control structure made up of data bases integrated into a wide range of Service and other planning/information storage systems.

PHASE III DUAL USE APPLICATIONS: The maintenance of large storage structures designed to archive large amounts of data are becoming more wide spread within the commercial market place. An example would be a multimedia database maintained by an international news organization. The Internet could also be considered an example of a very large, disorganized database that is changing rapidly enough that identical searches made within minutes of each other could yield different results.

DARPA SB982-015 TITLE: Course Of Action Analysis Within A Strategic/Tactical Planning Environment

CRITICAL TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: Develop a set of robust tools/techniques that can be used within a planning system/process (such as those used by the military or within the commercial corporate planning environments) process to aid a strategic planner in developing a better understanding of a particular course of action. Tools/techniques developed should allow a planner to not only gain a better understanding of the pros and cons of a potential course of action (such as identification of risks) but should also aid the planning process by (1) allowing less experienced planners to develop robust/mature courses of action, and (2) allowing the overall process to be completed much faster and with higher quality than is possible today.

DESCRIPTION: The planning process is complex and very subjective. The wide range of variables that must be considered, and the fact that much of the related data is incomplete, inaccurate, outdated or just not available, makes the planning process art as much as a science. Technology is becoming available to the commercial/military planner to assist in the planning process, but few automated tools are available to rapidly analyze a potential course of action to understand its strengths and weaknesses.

PHASE I: Identify advanced concepts and technologies which will offer the potential to improve the planning process by allowing planners at all/any levels of a corporate/military structure to quickly and accurately understand the inherent strengths and weakness of a potential course of action. Identify several prime candidates for development in a Phase II program. Low technical risk and high potential for successful development will be included in the ?technical merit@ selection criteria.

PHASE II: Develop and test one or more techniques/algorithms selected in Phase I by integration (if practical) within an existing planning system. Establish performance criteria and verify through one or more experiments designed to measure planning performance improvements against a set of metrics developed in Phase I.

PHASE III DUAL USE APPLICATIONS: The use of support tools is becoming an acceptable method of planning within all levels corporate and military mission planning. Although particular applications vary widely, the underlying technologies required to analyze a potential course of action is applicable to both environments.

DARPA SB982-016 TITLE: Visualization Of Information Within A Mission Planning Context

CRITICAL TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: Military planners use detailed maps of the terrain, combined with relevant information derived from a variety of sources to understand potential actions/counter actions that are available to both himself and his opponent. This approach has worked well for hundreds of years since most military operations occurred in physical space. However, part of the shifting in military warfare present today is from action in 3D space, to actions dealing with the gathering, interpretation and use of information as a military weapon. Military planners today have sophisticated tools available to visualize 3D space, such as paper or electronic representations of terrain, but they do not have an equivalent for visualizing the 'information space'. This effort is designed to focus on this limitation by providing military commanders with ways of displaying what information someone knows, how he knows it, how good it is and how what someone knows (or does not know) can be used to manipulate the outcome of a military engagement (or to prevent such an engagement). Develop techniques that allow military planners to determine what military information, relevant to their tactical situation, is available to an adversary, and present the data in such a way that a military planner can use the data for course of action development.

DESCRIPTION: Military planners rely on information derived from a wide range of sources as the basis of their decision making process. This information represents the collective understanding of the current situation of friendly, enemy and neutral components. It also represents the best understanding of what information an opposing force may have as well about his current situation. To obtain the goals set forth for a particular operation, planners must be able to quickly integrate relevant data and develop an understanding of both current and future situations, so as to rapidly take advantage of opportunities as they present themselves. Information Operations is a term broadly used to describe the emerging area of military operations related to understanding information flow on a battlefield and how it effects military outcome. By being able to better understand how this process occurs, military commanders are better able to understand and manipulate a situation to either take advantage of a lack of situational awareness by an opposing commander, or by doing things that add to his confusion of the situation. However, in order to do this, methods of displaying the 'information terrain map' must be developed.

PHASE I: Identify advanced concepts/algorithms which will offer potential improvement in the ability of military commanders to understand what information is available and how it can impact his planning and execution process. In particular, visualization techniques should be used that allow a commander to rapidly understand the 'information terrain' as well as provide techniques to analyze potential actions that could be taken based on this information. Low to medium technical risk and high potential for successful development will be included in the ?technical merit@ selection criteria. Identify experimentation techniques and metrics that would be used in a Phase II effort to validate.

PHASE II: Develop and test one or more techniques/algorithms selected in Phase I by integration within a command and control planning structure as proposed in Phase I. Execute experiments to validate the concepts/algorithms developed against the metrics identified in Phase I.

PHASE III DUAL USE APPLICATIONS: The basis of any planning systems, whether it's used within a military context or for corporate strategic planning, is information. The art to planning is understanding who knows what and what advantage can be gained by understanding an opponents lack of situational awareness. The opponent could be another military commander, but could also be a corporate competitor. Although the information critical to planners within a military or corporate environment will be different, the underlying technologies necessary for visualization of the information 'terrain' are similar.

DARPA SB982-017 TITLE: Tools, Algorithms and Sampling Techniques for Logistics Execution Monitoring Technology

CRITICAL TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: Develop logistics execution support algorithms and data sampling techniques that can provide real-time information to support the development of alerts and triggers for rapid logistics replanning processes.

DESCRIPTION: Research and development of technologies that support real-time visibility of assets in the logistics pipeline, and the infrastructure that support their conveyance, are needed to support the DARPA Advanced Logistics Program (ALP). Areas of interest include the development of Asentinels@ that understand the explicit assumptions and expectations of plans, sample and interpret execution data, detect deviations, and trigger logistics replanning processes. Other important aspects include innovative and comprehensive methods for monitoring the execution space, including the condition of the infrastructure, as well as assets in motion and in storage, and inexpensive labor free methods for aggregation and deaggregation of materials in flow. These solutions require advancement of multiple enabling technologies that support execution monitoring in a continuous replanning environment and their integration into an end-to-end system solution.

PHASE I: Define and evaluate algorithms that provide for the creation of plan ?sentinels@ that capture expectations and assumptions of logistics plans and provides triggering logic to initiate replanning when deviation thresholds are detected. Investigate techniques and hierarchical system concepts involving active and passive tags that can be used to support visibility of real-time logistics flow, aggregation/deaggregation processes, and infrastructural state. Phase I efforts are focused at enabling technologies within DARPA ALP. Knowledge of the DARPA ALP system architecture will be required to facilitate integration during Phase II. (For information on the DARPA ALP Program, go to the DARPA Homepage at ?https://www.iso.darpa.mil@. Click on ?C2/Planning@. Then, ?Advanced Logistics Project@.)

PHASE II: Integrate algorithms and sampling techniques into the system architecture being defined and developed as part of the DARPA ALP. Demonstrate the creation of ?sentinels@ in support of a changing logistics support plan and replan triggers caused by disruptions of flow and/or loss of infrastructure. Demonstrate the potential for automated aggregation/deaggregation processing at critical nodes in the logistics pipeline.

PHASE III DUAL USE APPLICATIONS: From a military standpoint, this technology will provide improved capability to monitor force deployments; the distribution of material, supplies, and equipment; and the condition of infrastructure supporting logistics operations. Examples include tracking the movement of military transport aircraft, cargo ships, trucks, and trains, as well as the military equipment and supplies being transported. It will also provide the capability to monitor the condition of sea/aerial ports of embarkation/debarkation, road networks, and highway/rail facilities. This improved visibility will result in faster planning and replanning during contingency operations, and improve the day-to-day efficiency and effectiveness of the logistics pipeline. From a commercial standpoint, these advanced monitoring technologies have a direct application to commercial logistics-oriented operations. The greatest potential value is in areas related to "just-in-time" manufacturing, supply-chain management, inventory management, physical distribution, and the management of transportation carrier operations, i.e., rail, truck, ship, and aircraft operations. It also has the potential to improve carriers' abilities to provide real-time feedback to the customers on the status of their individual shipments.

DARPA SB982-018 TITLE: Ultra Low Bandwidth Video Coding & Indexing

CRITICAL TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Develop algorithms, software, and special hardware (if needed) to provide high quality, ultra low bandwidth video encoding and indexing (on the order of 10 times fewer bits per second than current Moving Pictures Experts Group 2 (MPEG2) compression schemes with comparable quality) that allow efficient, near real-time retrieval, dissemination, archiving, and search of video sequences for military applications, such as surveillance and reconnaissance, gun camera video for battle damage assessment, and mobile collaboration.

DESCRIPTION: Today=s commercial MPEG1 and MPEG2 video compression products are too bandwidth intensive for many military operations and have little support for indexing and retrieval. Major future improvements will rely on approaches that characterize changes in video content by extracting discrete objects in a scene, tracking changes in those objects and the camera, and transmitting only those changes. Simulation and computer graphics techniques can help reconstruct image frames in real-time on the receiving end. As an added bonus, meta data describing video content is extracted during compression and can be used to archive, search, and retrieve video segments. Several relevant international standards efforts are underway, including MPEG4, Multimedia and Hypermedia information coding Expert Group 5 (MHEG5), MPEG7 and Virtual Reality Markup Language (VRML). These standards will lead to commercial technology applicable to military requirements for video compression, dissemination, and warehousing. However, many types of military video, for example airborne infrared reconnaissance, will require special adaptations and extensions of commercial technology designed for broadcast TV and entertainment markets. Real-time military applications may also require special hardware beyond that found in commercial products.

Efforts of interest include identifying emerging commercial products conforming to emerging international meta data and low bandwidth video compression standards, identifying unique DoD requirements and algorithmic modifications of commercial products needed for military applications, and demonstrations of very low bandwidth video dissemination and data bases using existing military networks and radios.

PHASE I: Select one or more military applications for analysis. Identify an approach to implementing ultra low bandwidth, high quality video compression and indexing. Explain how the proposed capability builds on standards-based commercial technology, defining any required extensions or modifications of commercial approaches and products. Quantify the expected benefits for military operations. Outline a program plan for demonstrating and evaluating the system in a military context.

PHASE II: Develop a standards-based military ultra low bandwidth encoder, indexer, server, and decoder. Demonstrate its effectiveness for video dissemination. Deliver documentation of the results and an analysis of the potential impact on military operations. Define required extensions to international standards for military applications.

PHASE III DUAL USE APPLICATIONS: The development of ultra low bandwidth video encoding, archiving, and dissemination has a huge potential commercial market for movies on demand, web-based video advertising and entertainment, and better collaboration and conferencing environments. Such encoding and indexing approaches require image understanding, exploitation, dissemination and information management technology developed in the DoD and in turn will lead to commercial components that will be applicable to critical DoD missions.

DARPA SB982-019 TITLE: Clutter Characterization

CRITICAL TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Unmodelled clutter, whether natural or man made, is one of the principal causes of high false alarm rates (FAR) produced by Automatic Target Recognition (ATR) algorithms and, therefore, represents a significant obstacle to the development of useful ATR systems. In order to quantify the performance and simplify the development of operationally useful ATR algorithms, it is highly desirable to have a rigorous and general mathematical characterization of the nature of radar image clutter and its effect on Synthetic Aperture Radar (SAR) ATR algorithms. A product of such an analysis would be the ability to predict, for any given generic ATR algorithm, relative changes in probability of detection (Pd), probability of identification (Pid) and FAR as a function of comparatively simple measurements of the background clutter.

DESCRIPTION: Existing SAR ATR algorithms make use of peaks, amplitudes, and other features of the image in order to match against target signatures. Empirical evidence suggests that performance of the ATR, especially FAR, vary depending on whether the background data is rural, desert, suburban, urban, populated with non-target vehicles, or other confusers. Is there a way to characterize clutter so as to predict false alarm rates, as well as an ability to discriminate targets? Then, if a mission consists of a particular mix of clutter types, an overall performance level can be predicted based on sampled measurements of the clutter types.

PHASE I: Define the mathematical methods to be employed in attempting to achieve a novel means of rigorously analyzing SAR clutter, and the process by which such characterization can be unambiguously applied to quantify the performance of ATR algorithms. The Moving and Stationary Target Acquisition and Recognition (MSTAR) SAR ATR system will be provided, as well as access to a collection of SAR clutter and target data. (For MSTAR SAR ATR information refer to this homepage ?https://www.mbvlab.wpafb.af.mil/public/mstar/@. This is a public site, despite the fact that it uses a secure server) The contractor will identify other SAR data and existing ATR algorithms for the purpose of developing a viable method to predict statistical performance levels as a function of measurements from the imagery.

PHASE II: Fully develop the mathematical models and methods proposed in Phase I, along with the requisite software. Their efficacy shall be demonstrated using the MSTAR system and other systems or data. Estimates of Pd, Pid and FAR shall be made for various clutter events (such as obscuration, varying background and confuser targets) and validated by simulation. Clearly, one way to make a performance prediction is to test the ATR on a sample of ground-truthed data. A successful mathematical model is one that greatly simplifies the process of characterizing clutter.

PHASE III DUAL USE APPLICATIONS: A successful demonstration of the ability to characterize clutter and its effect on SAR ATR systems could significantly improve remote sensing operations with incumbent advantages in geophysical and agricultural prospecting, environmental monitoring and disaster assessment and management.

DARPA SB982-020 TITLE: Decision Process Analysis Toolset

CRITICAL TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: Development of tools to assist in the identification of what information is important at what times in the tactical decision making process.

DESCRIPTION: Research and development leading to the production of a toolset which will capture the key steps in decision making processes to help identify the critical information required. Effort may include tools which identify bottlenecks in information flow, but should provide knowledge of essential and non-essential information presented to the decision maker. Proposals must include what types of decision making processes will be investigated, and the degree of automation expected in the toolset.

PHASE I: Establish the design of the knowledge acquisition toolset. Identify a scenario in which the toolset can be tested.

PHASE II: Complete development of the toolset. Demonstrate its use in specific scenarios and identify the critical information used by the decision maker and non-critical information presented to him.

PHASE III DUAL USE APPLICATIONS: The developed toolset will afford the opportunity to improve or automate any decision or control process. For example, the increasing application of advanced information technology within the commercial sector has resulted in the emergence of near real-time business decision systems. Such systems are used for inventory tracking and order submittal, credit verification, loan approval, and just in time manufacturing tracking. The identification of critical information in the decision making process provided by this toolset supports these systems in two ways. First, knowledge of the critical information facilitates the design of the decision logic central to these systems. Second, the information networks feeding these decision systems can be tailored to ensure that critical information is received while avoiding use of bandwidth to send extraneous information.

DARPA SB982-021 TITLE: Logistics Telemaintenance Analysis and Repair Using Web Compatible Tools

CRITICAL TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Develop and demonstrate web compatible remote viewing, video teleconferencing, and remote control tools that permit expert maintenance technicians, using low bandwidth and desk top computers, to perform fault analysis and repair on complex equipment.

DESCRIPTION: Downsizing and consolidation continue to impact all facets of logistics, particularly in the area of maintenance and repair of complex equipment. The experience base and number of highly qualified repair technicians may be declining while weapons system complexity continues to expand. Desktop and laptop computers, connected via the internet, may provide the opportunity to share the knowledge and experience of a few highly skilled technicians to remotely conduct diagnostic and repair activity at widely dispersed locations under field conditions.

The Joint Logistics Advanced Concept Technology Demonstration (JL ACTD) would demonstrate video conferencing applied specifically to the maintenance functional area within logistics to perform remote instrument monitoring and control, interrogation and fault detection, diagnostics, and repair of complex, high cost equipment using the internet and alternative communications media that minimize communications bandwidth requirements.

PHASE I: Design and develop the framework for application of web-based telemaintenance concept to military maintenance activities in a deployed environment. This activity includes identification of specific military equipment applications for use in demonstrating the technology and may include the identification and prototype on-line integration of specific military equipment test sets with applicable commercial off the shelf (COTS) hardware and software components.

PHASE II: Develop and demonstrate the web-based, collaborative telemaintenance tools designed in Phase I over internet connections using laptop computers and low bandwidth. Assess the value, implications, and impact of web telemaintenance capability to the field of military logistics.

PHASE III DUAL USE APPLICATIONS: Successful completion of Phase II would have applications across all services and could help to develop a Central Maintenance Center concept for multiple platforms, bases, or ships by linking the various nodes via low-cost web-based internet servicing. Similar and expanded requirements for this tool could be found in the commercial environment that faces similar challenges and could be expanded to include computer based hands-on distance learning.

DARPA SB982-022 TITLE: Improving Quality of Life and Workplace Productivity in an Information Rich Society

CRITICAL TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Develop information technologies that will improve productivity in the DoD workplace while improving the quality of life of the work force.

DESCRIPTION: Develop technologies that will improve productivity in the DoD workplace while improving the quality of life of the work force. For purposes of definition, Aproductivity improvement@ is measured as an increase in percentage of time in the workday devoted to core competencies while generating equivalent information products, and Aquality of life improvement@ is measured through a reduction in tasks not related to core competencies, reduced intrusion in the workflow and a reduced workload while generating equivalent information products.

Information age technology, centered on ubiquitous communications and affordable personal digital processing, has drastically altered the workplace and lifestyles of the modern work force. The modern workplace is rapidly migrating to a fully mobile virtual environment based on a matrix management structure with administrative functions being absorbed throughout the organization. Middle and senior managers routinely open and draft responses to all correspondence (e-mail), prepare draft and final documentation (memo=s, reports and briefings), arrange travel (internet search), coordinate meetings and calendars and prepare and review financial data. While the work force, at all levels, has become more efficient in terms of productivity, the blurring of the administrative and management/technical functional roles together with the availability of mobile personal processing has drastically altered the extent and content of the workday. Moreover, communications and networking technology has enabled an unstructured intrusiveness on the staff (from the mailroom to the CEO) in the sense that potentially anyone can add (even when not intended) to the day-to-day administrative workflow (e-mail buffer growth). Taken together, the quality of life has been made worse by the lack of distinction between the Atraditional office workday@ and Amobile virtual workday@ performed in the virtual office (office, transportation node/link, home). The percentage of time spent on financial and clerical administrative functions is increasing at all levels thereby reducing productivity in core competency areas. This non-productive trend is particularly exacerbated in the information rich government environment as it responds to aggressive downsizing pressures.

Technologies of interest include: office automation technology and proxy attendant services whereby network and client software provides clerical, financial and information gathering functions that operate on behalf of the work force staff (as a proxy) providing Avirtual staff@ assistance for routine workflow functions. Examples include, but are not limited to: 1) e-mail: auto folder formation based on thematic content, content summarization, collaborative mail management, reroute/trash/respond, alertment and communication mode switching (e-mail/pager, e-mail/phone), verbal mail debrief and generation; 2) facilitating workflow: scheduling (individual/group) and time management, collaboration management, task prioritization and tickler generation, productivity evaluation, financial analysis/ tracking and monitoring, team formation and intrusion management; 3) information retrieval: thematic document summarization, semi-automated thematic Internet search with natural language interface; and 4) information storage/retrieval: automated filing, information collation, proxy trash and house cleaning.

PHASE I: Select one or more military organizations for analysis. Identify an approach to implementing office automation and proxy attendant services. Explain how the proposed approach builds on standards-based commercial technology, defining any required extensions or modifications of commercial approaches and products. Quantify the expected benefits for military operations. Outline a program plan for demonstrating and evaluating the system in a military context. Efforts leading to a focused small scale demonstration of technology that validates the project objectives are highly desirable during this phase.

PHASE II: Develop technologies that will improve productivity in the DoD workplace while improving the quality of life of the work force. Demonstrate infrastructural capability through moderate sized experiments involving all echelons of the government work force, software applications, and other technologies that validate achieving the metrics for productivity and quality of life improvements: Aproductivity improvement@ is measured as an increase in percentage of time in the workday devoted to core competencies while generating equivalent information products, and Aquality of life improvement@ is measured through a reduction in tasks not related to core competencies, reduced intrusion in the workflow and a reduced workload while generating equivalent information products. Deliver documentation of the results and an analysis of the potential impact on military and government operations.

PHASE III DUAL USE APPLICATIONS: The development of improved office information technology has a huge potential for commercial market. The commercial information environment is under the same pressures as it responds to aggressive downsizing moves. Applications to improve information productivity and quality technology developed in the DoD have direct dual use applications in the commercial sector.

DARPA SB982-023 TITLE: Micro-RoboticTaggant/Sensor Platforms

CRITICAL TECHNOLOGY AREA: Chemical and Biological Defense

OBJECTIVE: Develop intelligent, programmable micro-scale sensor technology capable of identifying facilities used in the creation of chemical and/or biological weapons (CBW).

DESCRIPTION: Current taggant technology is based on fixed chemical structures designed specifically to identify the source of a dangerous substance to assist law enforcement in identifying the perpetrators after the fact of a violent act (e.g., a bombing). Today's taggants are relatively indiscriminate (meaning they tag a lot of things besides drug facilities), and they provide little or no explicit evidence of CBW manufacture. The combination of things represented by micro-robot behavior would provide a unique signature for a confluence of events, such as the presence of a known perpetrator at a facility where drug paraphernalia is present, and at a place where precursor chemicals are also present. This confluence uniquely identifies the behavior in question. The technology sought would create micro-scale programmable robotic sensor platforms with cooperative behaviors appropriate to the identification of facilities employed in the creation of CBWs. Approaches might include the application of micro electro-mechanical systems (MEMS) to robot fabrication. The micro-robotic platforms sought would have a maximum dimension of 1 cm to 1 mm and would have minimum dimension components as small as .01 mm. These devices would be manufactured in minimum lot sizes of 10,000 micro-robots per wafer or per batch. Each batch would have programmable properties per batch (e.g., Batch A has specific properties distinguishable from Batch B). Devices would each have a few simple behaviors such as move, change direction and respond to the presence of something in the environment (e.g., of a chemical to be sensed). The devices should be powered by mining energy from the environment (e.g., micro-solar power); but micro-scale energy storage (e.g., micro-battery) technology is not precluded. Cooperative behaviors shall include recognition of members of other batches, and linking with such members to become a composite robot capable of behavior different from the constituent micro-robots. In a law-enforcement concept of operations (CONOPS), for example, Batch A micro-robots might be introduced in pre-cursor chemicals while Batch B micro-robots are introduced on a suspected perpetrator's clothing. The devices might be light enough in isolation to randomly collide in air currents, finding each other and joining to form a system that would then perform some behavior detectable by a criminal investigator (e.g., massing together and settling on objects to form "splotches" detectable under ultra-violet light). The presence of such splotches on clothing or in a building could be the basis for a search warrant. The research should identify environmental health and safety issues, if any.

PHASE I: Component Phase: Produce critical micro-robotic platform or sensor component(s) in the context of a total micro-robotic sensor system design concept that addresses the law enforcement CONOPS cited above or some reasonable variation thereof. A deliverable research briefing shall include a preliminary listing of applications, system concept, micro-robot characteristics, research issues; and potential environmental, health and/or safety issues.

PHASE II: Subsystem Phase: Fabricate at least two different micro-robotic subsystems capable of linking with each other. Define mechanisms to control, direct, or channel individual micro-robot component behavior such as by spray-painting a chemically unique "line" for them to "walk" along from a friendly facility into a suspected CBW facility. Define mechanisms for controlling programmable and/or aggregated behaviors, such as selecting between a light-seeking behavior and a warmth-seeking behavior in the field. Define manufacturing process that would produce these subsystems in large batches inexpensively. A deliverable research report shall characterize applications, concepts of operation, subsystem characteristics; and any environment, health and/or safety issues and shall indicate measures to protect the people and/or the environment or to provide for easy clean-up or decontamination.

PHASE III DUAL USE APPLICATIONS: The small business should be prepared to seek additional non-SBIR capital to manufacture several batches of micro-robots with distinct individual properties and useful aggregate behaviors and demonstrate their use in a simulated law enforcement scenario. The commercial sector might employ such micro-robots in manufacturing (e.g., detect when two chemicals that should not be mixed in a manufacturing process are being mixed, or are being mixed in inappropriately large quantities [e.g., for defect indication]). Electronics manufacturers might employ micro-robots to create thin-wire "patches" on small batch Application Specific Integrated Circuit (ASIC) semiconductors so as to avoid re-manufacturing (e.g., by tagging the desired endpoints of the desired patch wire under the microscope so that micro-robots could join head-to-tail between these points to form an insulated wire chain, effecting a patch on the bare die). Law enforcement could use the micro-robots for scenarios indicated, while the military could apply the micro-robots to implicate facilities as having some role in CBW during on-site inspections.

DARPA SB982-024 TITLE: Moving Target Indication Radar Architectures for Tactical Targets in Foliage

CRITICAL TECHNOLOGY AREA: Sensors

OBJECTIVE: Development of VHF/UHF receiver architecture and adaptive processing algorithms to enable Moving Target Indication (MTI) in foliage penetration (FOPEN) radar systems.

DESCRIPTION: Most military targets must move out of hiding to perform their missions, and will choose possible routes obscured by foliage. The requirements on a FOPEN MTI system are to employ a VHF/UHF radar system on an airborne platform or for fixed installation for local area intrusion detection, and to detect and track moving targets in a heavy foliage environment. Current FOPEN Synthetic Aperture Radar (SAR) requires high signal bandwidth, long integration times, and wide integration angles in order to obtain the necessary resolution for fixed target detection. Conversely MTI radar utilizes modest bandwidth, narrow beamwidths, and multiple coherent integration intervals to discriminate moving targets from background clutter. The target motion itself, which produces false-alarms in SAR imagery, provides a valuable discriminant between military threats and intruders and non-threat objects.

Architectures should consider novel implementation of low-cost digital receivers, dispersed location of VHF/UHF receiver implementation for waveform direction finding and sidelobe control, space-time adaptive processing for segregating signal doppler from clutter, and interference suppression in the dense VHF/UHF environment. Novel architectures that have the potential for combining waveform diversity in bandwidth and coding for fixed (SAR) and moving (MTI) target detection, with sufficient resolution for interference cancellation and feature extraction should be emphasized. High performance computer processing architectures and any constraints on implementation in real-time should be considered.

PHASE I: Produce techniques, performance predictions, and estimates of processing requirements.

PHASE II: Develop the processing software implemented on an available high performance computer.

PHASE III DUAL USE APPLICATIONS: The military application is an adjunct to the FOPEN SAR Advanced Technology Demonstration currently being developed. Commercial applications include use of remote sensors for intrusion detection, and adaptive receiver processing for cellular communications and co-site interference cancellation.

DARPA SB982-025 TITLE: Extended Storage Technologies for Aircraft Components and Sub-Systems

CRITICAL TECHNOLOGY AREA: Air Vehicles / Space Vehicles

OBJECTIVE: Development of advanced technologies to enable storage of combat aircraft for extended periods of time (on the order of 1 year) without routine hands-on maintenance.

DESCRIPTION: Current aircraft require routine operation during peace to maintain aircraft flight worthiness and to exercise aircraft systems, avionics and weapons. This flight conditioning has a fundamental impact on the way aircraft are designed and maintained, and therefore on how it accrues cost. An aircraft that can be maintained in flight ready storage for extended periods of time can enable significant reductions in Operations and Support (O&S) costs through dramatic reductions in the number of maintenance and support personnel required during peacetime. Technologies are sought that have the potential to enable this concept of long term storage by addressing current systems that require frequent exercise and maintenance. Efforts may address any field of aircraft design for which significant benefit can be demonstrated; however, advanced technologies in the areas of propulsion, modular avionics, reduced fluid systems and complete air vehicle storage for unmanned systems are of particular interest. Efforts may address technologies at the component, sub-system or architecture level, but in all cases proposals must clearly state how the development integrates and benefits the entire system design.

PHASE I: Develop the technology concept to explore the implementation in a systems context, quantitatively assess the impacts to vehicle performance, quantify the benefits and potential O&S cost savings, and explore the limits for extended and short term storage. Develop the candidate technology to the level required for the conduct of Phase II proof-of-concept demonstration.

PHASE II: Complete development of the extended storage technology as required to demonstrate application of the concept. Validate, through both rapid aging processes and real-time extended storage tests, the capability to store the system without routine maintenance and rapidly bring the system to operational status for deployment within 24 hours. Complete documentation of tests and results must be delivered.

PHASE III DUAL USE APPLICATIONS: The development of extended storage components will dramatically reduce support requirements of aircraft in the inventory regardless of ownership. Successful implementation of extended storage has the potential to reduce the overhead of maintenance and support personnel in the commercial airline industry. In addition, the civil aviation market can exploit storage technologies (with rapid deployment capabilities) to reduce the periodic maintenance requirements resulting in a cost saving to private aircraft ownership.

DARPA SB982-026 TITLE: Dismounted Warfighter Antenna System

CRITICAL TECHNOLOGY AREA: Command, Control, and Communications (C3)

OBJECTIVE: Design and demonstrate an antenna which can be integrated into the load-bearing equipment of the soldier/marine without protruding more than a few cm from the load-bearing equipment.

DESCRIPTION: Design and demonstrate an antenna which can be integrated into the load-bearing equipment of the soldier/marine without protruding more than a few cm from the load-bearing equipment. The antenna must operate with reasonable gain (> -10 dBi) in the 30 to 88 MHz band, the 225 to 400 MHz band and the 1 to 2 GHz region with wideband signals (up to 10 MHz instantaneous bandwidth). The antenna must consume little power (< .5 W) and operate equally efficiently when the soldier/marine is standing, kneeling or prone.

PHASE I: Perform analysis and trade studies of alternate antenna concepts. Develop several candidate antenna systems.

PHASE II: Build prototype antenna systems and perform calibrated antenna tests with the antenna mounted on a warfighter in standing, kneeling and prone. Compare modeled antenna gain to measured antenna gain. Conduct initial reliability, wearability and durability tests.

PHASE III DUAL USE APPLICATIONS: Personnel communications are becoming ubiquitous. Currently, police and other security personnel wear their communications equipment instead of carry it. In the future, wearable communications will be the norm for most users. Wearable antennas currently are inefficient and waste battery power. The development of efficient, wearable antennas would greatly reduce the required radio battery size which would make a significant reduction in the cost and size of future wearable communications equipment.

DARPA SB982-027 TITLE: Combat Control Performance Accounting

CRITICAL TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: Define and develop a standard quantitative performance accounting methodology for Combat Control.

DESCRIPTION: The desired performance accounting approach is intended to provide a rigorous unified theoretical underpinning for Combat Control system development, acting as an analog for Combat Control to the role likelihood theory plays for sensor detection and parameter estimation problems. It is expected that such a formulation would provide first principles insight into the optimal structure and architecture of Combat Control systems, improved understanding of the critical issues in Combat Control system design, and improved definition and standardization of Combat Control system performance metrics.

PHASE I: During Phase I, the zero order state variables and system metrics would be defined and the fundamental constituent equations enumerated. Reduced complexity simulations would be conducted to identify critical linkages and highlight potential simplifying assumptions.

PHASE II: During Phase II, a full-scale simulation would be created and exercised for the one-on-one engagement problem. Optimal (possibly jointly optimal) approaches for sensor employment, tactics generation, and vulnerability minimization would be defined. Independent/dependent variable sets would be identified. Simulation testing to assure critical (necessary and sufficient) sets of both state variable and system metrics would be conducted. The attendant system architecture, that the above optimal approaches specify, would be investigated. Possible objective functions for Combat System design would be evaluated. A software package allowing for easy manipulation of the resulting conceptual package would be created.

PHASE III DUAL USE APPLICATIONS: The result would be potentially applicable to military and naval tactical decision making at the unit commander level and to engineering requirements definition at the Combat System level. The result would also be potentially applicable to quantitative optimal decision making for complex problems in the business, transportation, and robotics domains.

DARPA SB982-028 TITLE: Fast Ship Drag Reduction

CRITICAL TECHNOLOGY AREA: Surface/Under Surface Vehicles/Ground Vehicles

OBJECTIVE: Design and quantification of novel drag and boundary flow modification methods to reduce skin friction on future high speed ocean vehicles.

DESCRIPTION: Research and development leading to skin drag reduction methods on fast moving ocean vehicles. These ships would typically be 5,000 to 10,000 tons total weight and moving at speeds of up to 70 to 100 knots over ranges of up to 10,000 nautical miles. Skin friction reduction is an essential element in attaining acceptable power and fuel requirements. Efforts of interest include modification of the boundary layer by hydrodynamical or viscosity manipulation at the skin. Research methods to estimate performance levels may include computational fluid dynamics and experimental support.

PHASE I: The results of a first phase of this effort would provide a detailed description of the newly proposed technologies and their expected quantitative performance in a scaled-up application for ship sizes as given in the above specification.

PHASE II: In this phase, the predicted properties of the proposed technologies would be modeled in greater detail and, where performance has not been demonstrated, experiments would support and show convincingly the viability of the proposed approach.

PHASE III DUAL USE APPLICATIONS: Skin friction reduction is an essential requirement in the design and construction of large fast ships. The military use of this technology is sea lift of equipment and troops for rapid deployment from CONUS to trouble spots worldwide. The commercial application is speed-up of delivering certain cargoes with the added advantage of being able to reduce platforms and manning as a result of quicker transfer and turn-around times.

DARPA SB982-029 TITLE: Mobile Munitions

CRITICAL TECHNOLOGY AREA: Ground Vehicles

OBJECTIVE: Development and demonstration of concepts and technologies for performing the functions of anti-personnel landmines without the residual hazard caused by fully armed mines left in unmarked locations after a particular action or conflict resolution.

DESCRIPTION: Anti-personnel landmines perform valuable military functions; they deny, delay, disrupt, and canalize enemy maneuver. However, because they may be left in place, fully armed in a variety of fused configurations, after an action or conflict resolution, they present a residual hazard that may result in unintended, indiscriminate casualties. DARPA seeks research and development leading to concepts and technologies for replacing anti-personnel landmines with mobile munitions. Capabilities desired for these mobile munitions include (a) ground mobility, (b) deployment on command in selectable patterns, (c) activation and render-safe on command, and (d) self-retrieval on command. DARPA favors concepts and technologies whose costs, assuming high-volume production, may be competitive with contemporary anti-personnel landmines.

PHASE I: Identify concepts for replacing anti-personnel landmines with mobile munitions; evaluate those concepts with respect to mission-effectiveness, cost, risk, and other relevant criteria; identify technologies enabling the most promising concepts.

PHASE II: Develop and demonstrate enabling technologies. Develop and demonstrate a mobile munitions system in a military scenario such as protecting high-value assets.

PHASE III DUAL USE APPLICATIONS: The development and demonstration of multiple mobile ground vehicles derived from the technology demonstrated in Phases I and II for mobility, re-configured for other payload packages, will enable dual use applications in numerous markets, including law enforcement, emergency response, disaster relief, security, surveillance, hazardous material handling, cargo handling, and surveying.

DARPA SB982-030 TITLE: GLASS TURRET Visualization Implementation

CRITICAL TECHNOLOGY AREA: Human Systems Interface; Command, Control and Communications (C3)

OBJECTIVE: Demonstrate display system to provide augmented, 360/ situational awareness visualization of fused multisensor, multispectral, and non-image data from external sensors.

DESCRIPTION: Situational awareness is a critical requirement for warfighters in modern combat. The requirement is so crucial that the warfighter sometimes puts himself at risk just to obtain more than the limited view normally provided inside his platform. A good example is the tank commander operating in the popped-hatch/heads out position during a battle to get a full view of the battlespace not afforded inside the tank. The objective of GLASS TURRET is to demonstrate the integration of technologies which would provide the warfighter with a full, on-demand view of the outside environment, augmented with information about each object he sees, based on data obtained from on- and off- platform imaging and non-imaging sensors, and fused and presented in a visualization implementation which would minimize impact on the warfighter=s movement, visibility, and performance.

This SBIR project will focus on the visualization implementation. Novel concepts are sought for displays which would be able to present fused, multispectral [e.g., visible, Infrared (IR)] imagery and nonimage data [e.g., Identify Friend or Foe (IFFN), capability, status alphanumeric data on relevant objects in the scene) to the warfighter in an easy to use, readily understandable fashion. The display should be synchronized to the warfighter=s head and eye position, in effect allowing him to ?see through@ the platform wall at the outside scene in the direction of his gaze. Concepts proposed should consider human engineering issues, as well as physical constraints characteristic of confined platforms such as tanks.

PHASE I: Detailed definition and initial design, at the level of Preliminary Design Review (PDR), of visualization implementation.

PHASE II: Fabricate, integrate, and system test a brassboard visualization implementation. Test brassboard in an enclosed platform, using sensors and algorithms generated by other portions of the GLASS TURRET program.

PHASE III DUAL USE APPLICATIONS: Situational awareness displays can be used in military and civilian applications in which the operator is confined to an enclosed volume, and must observe the hostile environment outside the enclosure. Civilian applications include firefighting, aircraft cockpits, factories, power plants, and mining facilities. Military applications include tanks, combat vehicles, scout vehicles, cockpits, and other warfighting platforms.